Understanding the Effects of Gravity on Plant Development

Two investigations on this mission focus on the effects of gravity on plant development. The first, *Gravitational Effects on Embryogenesis in Poaceae*, will examine the developing seed embryo in orchardgrass. The second, *Gravity Effects on Seedling Morphogenesis*, investigates the structure of germinating cucumber seedlings. Together, these experiments will add to the previously acquired store of information on plant development, growth, and behavior in space.

The objective of the Biological Research in Canisters-13 (BRIC-13) payload, *Gravitational Effects on Embryogenesis in Poaceae*, is to study the role of microgravity on embryo formation (embryogenesis) in orchardgrass (*Dactylis glomerata* L). Embryogenesis in plants is a critical step in seed formation and reproduction. Previous studies have indicated that the space environment can inhibit the earliest cell divisions that lead to embryo formation.

Scanning electron micrograph of a fully developed embryo arising from a cultured leaf segment of orchardgrass

A reduction in embryogenesis could lead to seeds that form improperly or seeds that are unable to produce another generation of plants. This has important implications for long-term spaceflights where crews would depend on plants for food, oxygen, and water. The understanding of embryo and cell division could also lead to advances in medical technology and pharmaceutical products.

The experiment will utilize BRIC hardware. Each BRIC is an aluminum cylinder designed to accommodate nine 100 mm petri dishes. Orchardgrass segments (3-4 mm each) will be plated on a nutrient gel prior to flight. The grass segments are prepared by splitting the leaf in half along the midvein and removing small samples from each half. One half is used for the flight experiment and the other half is used as a ground control. For both flight and ground, two canisters will be at room temperature and one canister will be stowed in a 4ºC passive cooler. The passive cooler uses two chemicals that change from a solid to a liquid at 4ºC, thus allowing cooling without power. During the flight, a crewmember will remove the canister from the cooler. Embryos will begin to form as the canister warms to room temperature. The experiment will be duplicated on the ground so that Earth gravity and microgravity effects from the same plant can be analyzed and compared.

The BRIC-PEG/C experiment will utilize the microgravity environment to characterize the gene expression of cell wall protein (expansin), during development of the hook and the peg. In germinating cucumber seedlings, two morphogenetic processes appear to require gravity: 1) the formation of the hook in the apical region of the stem, and, 2) the formation of a peculiar outgrowth, known as the “peg” at the transition zone between the stem and the root.

The development of these organs in gravity involves a major change in the pattern of cell expansion. The expansin protein has a significant role that catalyzes cell enlargement by promoting the slippage and relaxation of the load-bearing network(s) in the wall.

Freezing of the BRIC-PEG/C samples in the gaseous nitrogen freezer

The results of the *Gravity Effects on Seedling Morphogenesis* experiment will yield greater insight into the action of expansins and their role in plant cell growth. This information will add to the understanding of the molecular mechanisms which control plant cell growth, with the possibility of inventing new ways to genetically engineer plants for improved growth characteristics.

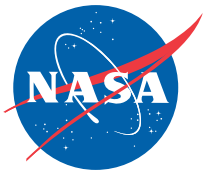
In the flight experiment, cucumber seedlings at various stages of development will undergo the transition into the microgravity environment of near-Earth orbit; these seedlings will be frozen while in orbit. The BRIC hardware will house the cucumber seeds. Approximately 10 seeds will be present in one petri dish, with eight petri dishes per canister. Each canister will be stored in SPACEHAB's refrigerator at 4ºC, and removed at specific timepoints. Thirty-six hours after launch, two of the four canisters will be frozen after removal from the refrigerator. The remaining two canisters will be received as fresh tissue upon landing. This experiment is part of a collaboration with Japanese investigators and is called the BRIC-NASDA payload.

Principal Investigator
Bob Conger, Ph.D.
Gravitational Effects on Embryogenesis in Poaceae
University of Tennessee
Knoxville, TN

Principal Investigator
Daniel Cosgrove, Ph.D.
Gravity Effects on Seedling Morphogenesis
Pennsylvania State University
University Park, PA

Project Manager
Guy Etheridge
NASA/Kennedy Space Center, FL

Project Scientist
William Knott
NASA/Kennedy Space Center, FL



National Aeronautics and Space Administration

John F. Kennedy Space Center
Kennedy Space Center, Florida

FS-1998-09-14-KSC